Space Weather Technical Forecast

Issued on Sunday, 03 July 2022 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms throughout the forecast period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low through the last 24 hours with no significant flare activity. There are currently four active regions on the Earth-facing disc. AR3040 (Cso/Beta) on the southwest limb is mature and will rotate off the Earth-facing disc in the next 12-24 hours. AR3046 (Dso/Beta) has demonstrated growth to the east of the main H-spot, with a number of apparent trailer spots, with magnetic looping to the main region. Tentatively, this area is attributed to AR3046, though may potentially be its own active region, with foreshortening of current imagery making the areas appear closer together than in reality. This region also produced a B7.3 flare, which may be the sign of further development and activity. The remaining regions are all weak, benign or fading. No Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: The solar wind speed as observed at L1, has been at background levels, generally varying between 300-330km/s, but with a recent increase to 330-350km/s. Density has varied erratically, with average values initially, but increasing to become above average from around 02/2000 UTC, with a peak of 47ppcc at 03/0756 UTC. A notable drop in density was observed from around 03/1000 UTC, close to average levels, possible attributable to the arrival of an expected slow CME. Total magnetic field strength started at moderate levels, around 13nT, due to the CME magnetic cloud from the 1st July, with the strength easing to 4nT by the end of the UTC day on the 2nd. A steady increase in the IMF back to moderate levels beginning around 03/0600 UTC was observed. The north-south component, Bz was predominantly positive, varying between weak and moderate. A more prolonged period of moderately positive Bz was seen from around 03/0700 UTC, with a peak of +10nT at 03/1143 UTC. The Phi angle has been mainly negative (away from the Sun), but periodic changes to the positive (towards the Sun) sector have taken place since around 03/0830 UTC. Geomagnetic activity was Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) as measured by GOES16 remained at background levels throughout the period. The high energy electron flux (greater than 2MeV) has been at mainly background levels through the last 24 hours. Electron fluence started above the Active (1e8 integrated pfu) threshold, has since fallen sharply reaching 2.13e6 integrated pfu at 03/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low or Very Low, with a very slight chance of Moderate activity.

Solar Wind / Geomagnetic Activity: Solar winds are currently at background speeds, however, the anticipated slow CME appears to have arrived at Earth today. Although Geomagnetic activity is currently Quiet, any more prolonged periods of negative Bz could see a slight chance of geomagnetic storms, given that the previous CME from 01 July may have primed the near earth environment. A further Earth-directed CME may arrive at the Earth either late on 05 or into 06

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July (Day 3 or 4).

A coronal hole high speed stream from coronal hole 96 may connect with the Earth on day 2 (04 July) with speeds of 500km/s possible, although this connection is low confidence, due to the relative positions of Earth and the feature on the solar disc. The high speed stream from coronal hole 97 is then likely to connect with Earth on 05 July with estimated speeds of 500km/s. There is a slight chance of G1/Minor Storms throughout much of the period, with a higher risk on day 3 due to the combination of the potential onset of the high speed stream from coronal hole 97 and the possible CME arrival.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is expected to remain at background levels. High energy electron flux (greater than 2MeV) is expected to be mainly moderate to background through the next four days, with a slight chance of reaching the high (1e3pfu) threshold in any quieter geomagnetic periods on diurnal peaks. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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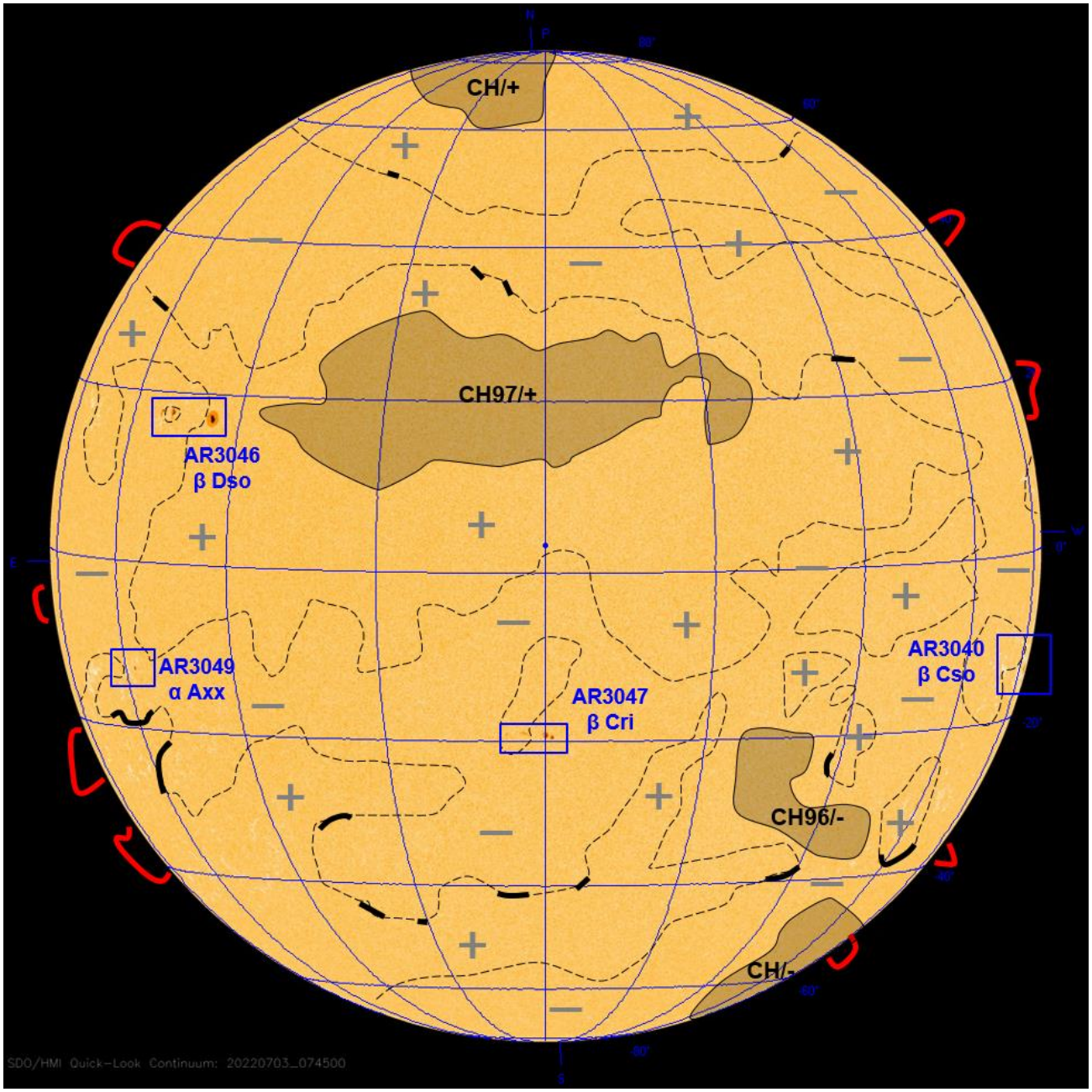
Figure 1. Solar Analysis Valid 03/0745 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Solar winds are currently at background speeds, however, the anticipated slow CME appears to have arrived at Earth today. Although Geomagnetic activity is currently Quiet, any more prolonged periods of negative Bz could see a slight chance of geomagnetic storms, given that the previous CME from 01 July may have primed the near earth environment. A further Earth-directed CME may arrive at the Earth either late on 05 or into 06 July (Day 3 or 4).

The high speed stream from coronal hole 96 may then connect with the Earth on day 2 (04 July). On passing STEREO A, this feature was observed with a high speed stream of around 700km/s and a significant CIR (co-rotating interaction region). Although the Earth is further north than STEREO A relative to the coronal hole, there is a chance that the Earth may observe speeds in the region of 500km/s.

On 05 July coronal hole 97 is in a more favourable position on the solar disc to connect a high speed stream with Earth. Estimates of possible speeds are in the region of 400-500km/s, but as this feature is non-recurrent, confidence is low in these estimates. Either later on day 3 or during day 4 a further CME, which left the Sun on 29th June, may arrive at Earth, although there is lower than average confidence in this aspect of the forecast. As this may be combined with the high speed stream connection, there remains a risk of G1/Minor Storms through days 3 and 4.

Overall, there is a slight chance of G1/Minor Storms on throughout much of the period, with a higher risk on day 3 due to the combination of the potential onset of the high speed stream from coronal hole 97 and the possible CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/1903	Partial	Filament	N18 W 0	200 km/s	Late 04 or on 05 July	Very low confidence

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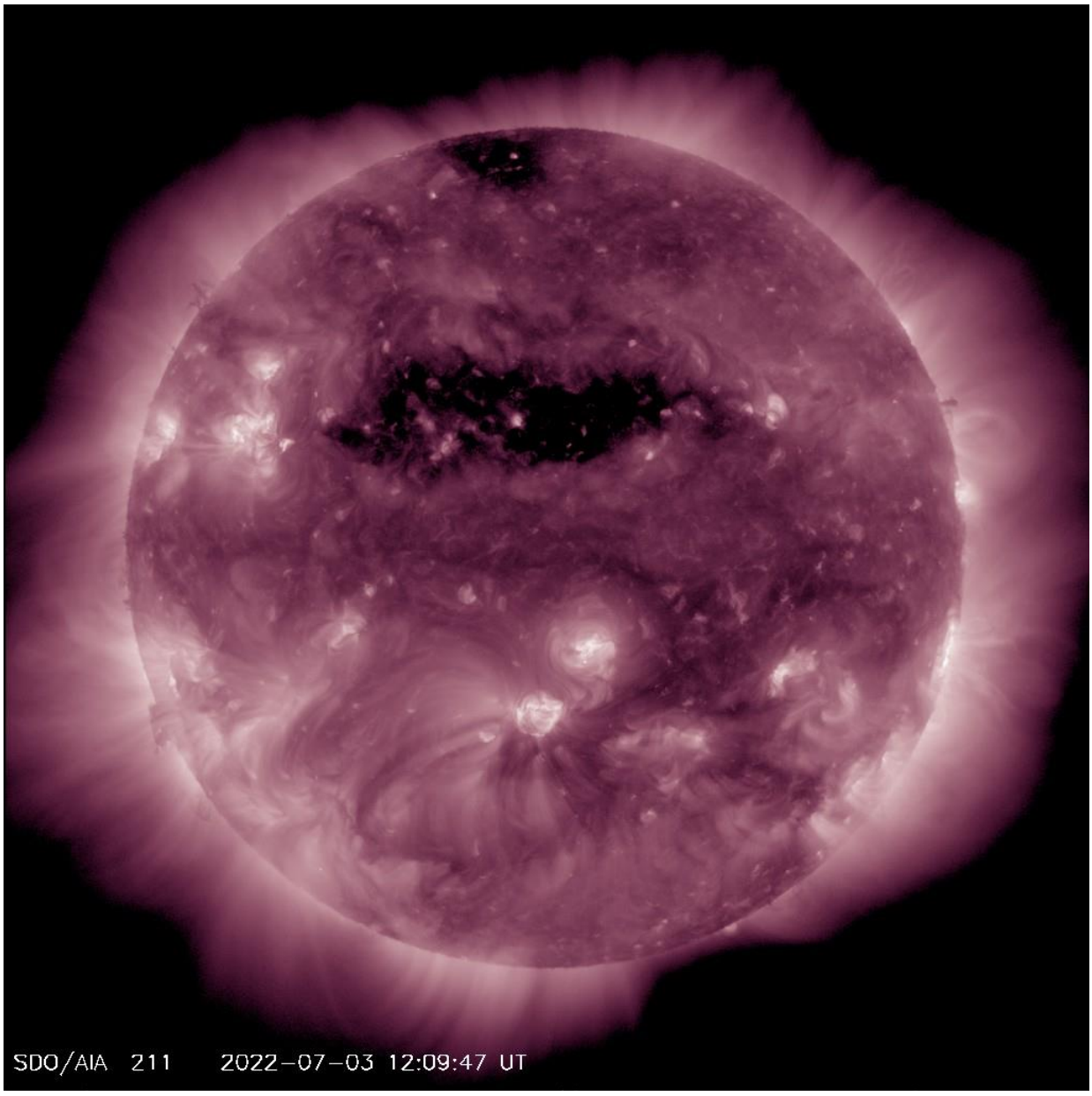
Figure 2: SDO/AIA 211 03/1209 UTC showing large coronal hole (CH97/+) in northern hemisphere centre disc



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Radio Blackouts - X-Ray Flares:

There are currently four classified sunspot regions on the visible disc, with AR3048 and the unnumbered region in the far northeast now decayed to plage.

AR3040 (Cso/Beta) on the western limb is retained as before, but significant foreshortening of available imagery means that the classification of this group will be unchanged until it rotates of the Earth-facing disc in the next 12-24 hours. The lead H-spot of AR3046 (Dso/Beta) remains broadly unchanged in size and appearance. To the east a number of small, trailer spots continue slow development, with magnetic looping to the main leader spot. Tentatively, this area is attributed to AR3046, though may potentially be its own active region, with foreshortening of current imagery making the areas appear closer together than in reality. AR3047 (Cri/Beta) appears largely inactive at this time, with no noticeable change in appearance. The new region in the far southeast is small, benign and stable, but has now been numbered AR3049 (Axx/Alpha).

A number of bright regions are apparent on or near the eastern limb of STEREO A EUVI imagery. The northern hemisphere region appears to be the returning AR3030 and would be expected to rotate on the Earth-facing disc on the 5th July.

Solar activity is expected to be Low or Very Low through the next four days, with a very slight chance of Moderate activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

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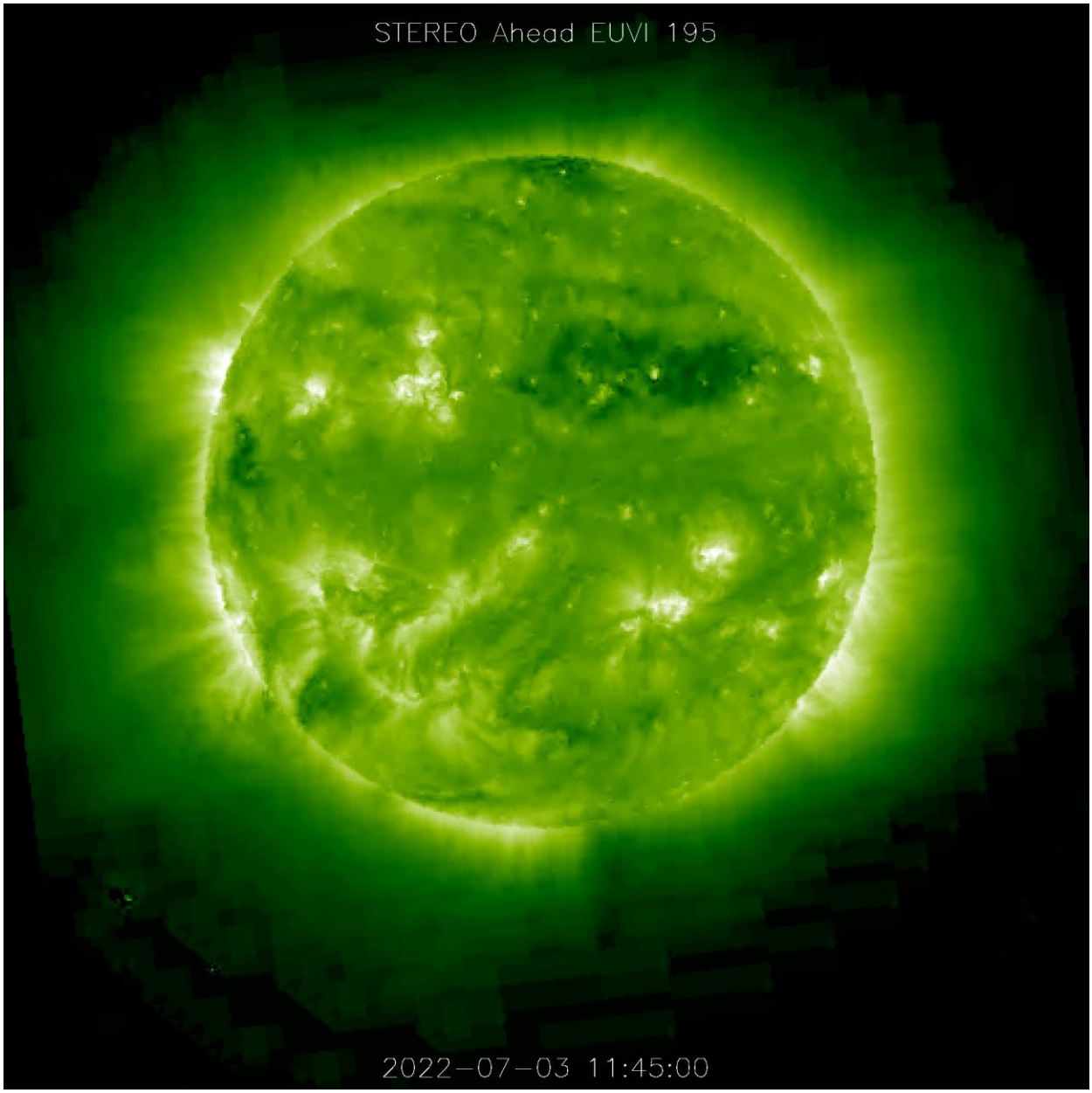
Figure 3: STEREO A EUVI 95 imagery 03/1145 UTC. New bright flux regions on eastern limb to rotate onto Earth-facing disc in the coming days.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has fallen to mainly background levels due to the redistribution in the belts following the geomagnetic storming on 01 July. Electron flux is likely to oscillate between mainly moderate and background levels due to the continued risk of storms. However, high (1e3 pfu) levels could be reached in any calmer intervals due to the large input of electrons into the belts from the forecast CMEs and high speed streams.

Electron fluence values have exhibited a sharp decline following the severe drop in electron flux values over the last 24 hours. Fluence is expected to remain below the Active threshold through the next four days, although slight upward trends are possible due to the possible periodic increases in electron flux.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	10	5	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: GOES16 Electron Flux and MOSWOC REFM output.

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